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Method of Applying Adhesive Coated Film

Field of Invention

This invention concerns articles and methods to save labor effort and improve quality of application in adhering adhesive-coated films to surfaces of substrates, especially those having irregular surfaces.

Background of Invention

Today, adhesive-coated plastic films, especially vinyl films with pressure sensitive adhesives or pressure-activated adhesives, are applied to a variety of surfaces for a variety of reasons such as advertisement, decoration, protection, and the like. Many of those surfaces contain rivets and other protrusions or indentations, such as the side of a truck trailer. When the film is applied over and adhered to these irregular surfaces, the film is strained to bring the adhesive into contact with the irregular surface. Residual stress in the film at such irregular surface locations often exceeds the holding power of the adhesive resulting in the film lifting off the surface to which it was adhered, particularly where the surface is irregular such as around a rivet or rib reinforcing the side of a truck trailer.

Current techniques for application to irregular surfaces involve applying most of the film with a small, plastic squeegee leaving a small area around the protrusion or indentation. Completing the application involves treating rivets to minimize lifting by heating the film with a heat source, usually a hot air gun or a torch, after the film has been predominately adhered to the irregular substrate. The film is typically heated while it is bridging the area around each type of surface irregularity, which can be summarized to be either a protrusion or an indentation. The film is not touched with the current tools because it is very soft and somewhat sticky. If it is touched, it is usually damaged. Because of the low mass of the film and the high temperature of the heat source, heating rates are several hundred degrees Celsius per second. Similar cooling rates are also occurring. When the film is then pushed into place with a tool, typically a squeegee for a rib or a rivet brush for a rivet, it is only slightly above room temperature. This does offer and

improvement over pressing the film without warming because the delayed crystallization time of the film makes the film more compliant. A rivet brush is usually a stiff brush, usually about 2.54 cm in diameter with 1.25 cm long bristles attached to a short wooden handle. If the film is too soft because of the heating when it is contacted with a circular motion using the rivet brush, the film is likely to be damaged. If the film is too cool, the stress is not eliminated adequately, lifting results eventually. In an attempt to relax the residual stress, the film is often heated after application, but the temperature to which the film can be raised is limited by the thermal conductivity of the metal surfaces underneath the film. It is therefore very difficult for one skilled in the art to assuredly adhere the adhesive-coated film to the irregular surface while the film is fully softened without also damaging the film structure or its appearance. If there is damage, the film is weakened at that location and diminishes the durability of the film. If there is an image graphic on that film, the image is distorted or destroyed at the damaged location. An aberration in an image, even if the image is as large as a mural on the side of truck trailer, is quite noticeable and unsatisfactory to the owner of the trailer, the marketer of a product shown in the mural on the trailer, and the graphic fabricator who has invested considerable labor and other effort to adhere the graphic film to the side of the trailer.

If the film lifts because of residual stress, the film could crack, peel back, or be damaged and otherwise not meet expectations for a surface that should have paint-like appearance.

Summary of the Invention

The present invention provides a method of adhering an adhesive-coated film to a substrate by heating the film to the softening point of the film and applying the soft film to the substrate with pressure using a Heat Neutral Pressure Source.

The present invention also provides an article for softening a film and adhering the film to a surface on a substrate, the article comprising a heat source and a Heat Neutral Pressure Source wherein the heat source and the Heat Neutral

Pressure Source direct heat and pressure at an intersecting location on the surface where the film contacts the surface.

Brief Description of Drawing

Fig. 1 is a perspective view of an illustration of an article of the present invention.

Fig. 2 is a perspective view of a second embodiment of the article of the present invention.

Fig. 3 is a perspective view of a third embodiment of the article of the present invention.

Fig. 4 is an illustration of another embodiment of the article of the present invention.

Fig. 5 is an illustration of another embodiment of the article of the present invention.

Detailed Description of the Invention

This invention recognizes a problem with adhesion of adhesive-coated plastic films, particularly vinyl films, applied to flat and irregular surfaces to provide improved appearance, durability, etc. For purposes of the present invention, an "irregular surface" is a surface that does not allow complete conformance of an adhesive coated film to its surface due to the presence of protrusions, indentations or other such non-planar geometries. Because the film is usually stretched during application, especially to accommodate an irregular surface, the pressure sensitive adhesive must hold the film to the surface under various stresses. Previously, only films with high performance adhesives have been used in such an application with success. Some of the most common challenging surfaces include corrugated and riveted truck sides, curved vehicle panels, channels in containers and vehicles, etc.

Surprisingly, the present invention provides excellent adhesion of thermoplastic films to highly irregular or textured surfaces, such as concrete, cement block, stucco, brick, fabric surfaces, carpeted surfaces and the like. Films applied to such surfaces without the method of the present invention have

significant portions that are not in contact with the surface of the substrate, particularly on the edges of the film. Films applied to such surfaces using the method of the present invention have the appearance of being painted on the surface, due to the close conformance of the film to the substrate. Further, the edges of the film are advantageously in close conformance to the substrate, thereby reducing the temptation of passersby to peel away the film.

For purposes of the present invention, a "highly textured surface" is a surface that is sufficiently non-uniform that a 4 mil film when applied thereto with a 4 kg rolling weight makes contact with the surface at less than 90% of its surface area.

As will be readily understood by anyone who has attempted to hang wallpaper, the application of an adhesive-coated film to a vertical surface is very cumbersome and time-consuming. Application of such materials to challenging surfaces such as truck trailers is that much more difficult. At the least the wall is usually even and does not contain compound geometrical or irregular surfaces. Typically, the size of a wallpaper section is about 70 cm wide and about 2.5 m long. In the pertinent art of the present invention, the application of an adhesive-coated film to a vertical side of a truck trailer occurs in a vastly different environment, a substrate that is often filled with topographical irregularities and film sections having a size of about 120 cm wide and about 3m long. Very skilled persons are needed for this assembly, and such assembly takes very long times: on the order of 22 hours per truck trailer.

The prior art method required individual treatment of each rivet area, including first punching holes in the film to allow air to escape, applying heat to the film to somewhat soften the film, and finally applying pressure using a brush to press the film down on the substrate using a circular motion and firm pressure. Because of the pressure and motion required in this application, the film could not be very soft at the time of brushing the film into place. The film had to be allowed to cool to a temperature at which the structural integrity of the film could withstand the forces imparted on it by the brush. It is not unusual for a least a few rivets of each trailer application using the prior art method to exhibit film damage or poor placement of the film over the rivet. The present invention, in contrast, allows

single stroke application of the film to the substrate on each rivet without concern over tearing or otherwise damaging the film through the swirling application of force through the rivet brush. This difference in application technique may reduce application time of applying a film to a truck trailer related to finishing the rivets of about 50%.

It is virtually impossible to fully soften the film such that all residual stresses are removed and still apply the film using conventional tools without damaging the films. Furthermore, lack of control of the heating process and very rapid cooling of the film after heating usually cause inconsistent results even with high performance adhesives and skilled applicators.

The use of films with removable adhesives is very desirable in the short term advertising market, i.e., displays of less than about 12 months. Films having removable adhesives are predominantly used on flat surfaces because the adhesives do not adequately resist the residual stress remaining after application to non-flat surfaces using prior art techniques. Much higher heat is required to fully relax the film than can be applied using only the standard squeegee and rivet brush.

Sub a1 For purposes of this invention, a "Heat Neutral Pressure Source" is a pressure source that has thermal conductivity characteristics and surface characteristics at the point of contact to the film such that the film, when nearly melted, will not adhere to the Heat Neutral Pressure Source during application in accordance with the method of the present invention to a surface.

With respect to the thermal conductivity characteristics, the composition of the film-contacting portion of the Heat Neutral Pressure Source does not appreciably conduct heat either to or from the surface of the film as the film is applied under pressure to a surface on a substrate. In other words, the composition has low thermal conductivity but can withstand high temperatures. Preferably, the pressure source has a Thermal Conductivity as measured by ASTM C-518 of less than 1.8 BTU/hr-in-ft2-°F.

Sub a2 With respect to the surface characteristics of the Heat Neutral Pressure Source, the film-contacting portion of the device has a geometry such that a soft or melted film does not distort or adhere to the film in a manner that would result in tearing or other such damage to the film. Thus, for example, while cotton is a

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material that is low in thermal conductivity, a cotton glove may be unsuitable for use as a Heat Neutral Pressure Source for certain film materials because its surface presents fibers and other such irregularities that provide intersticies for flow of a highly softened or melted film therein and furthermore adheres to many highly soften films. The surface characteristics of a cotton glove, therefore, leads to disruption of the appearance of the film in an attempt to carry out the process of this invention.

The suitability of any specific material for use as a Heat Neutral Pressure Source in conjunction with any particular film is quickly and routinely determined by applying an adhesive coated film suitable for application to the intended substrate to an irregular surface (such as the rivet portion of a truck-trailer wall), heating the non-contacting portion of the film to nearly its melting point, and immediately pressing the film to the substrate in an essentially perpendicular manner (without applying rotational force) using the material to be tested. If the film sticks to the material or otherwise is damaged by the material, the material is not suitable for use as a Heat Neutral Pressure Source.

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Preferably, the pressure source is compressive to allow full contact of the film to be adhered to the substrate to be adhered to. Thus, if an intended substrate contains a rivet that stands out from the plane of the substrate, a pressure source that is not compressive will not conform around the protruding rivet, and thus will allow non-contact or "tenting" of the film to occur at the base of the rivet. A preferred pressure source will allow full conformation or compliance of the pressure source around any surface irregularity to be encountered in the intended application. Preferably, the material has a Poisson's ratio of less than 1, and more preferably less than 0.9.

Preferably, the pressure source is a foam material. Such materials, when properly selected, provide a high degree of conformation, and additionally can be very low in thermal conductivity. More preferably the pressure source is an open cell foam material. Most preferably, the pressure source has a uniform surface structure such that when placed on a molten film material, the film will not exhibit visible structure imprinted from the pressure source. Particularly preferred pressure sources of the present invention are hand-held dauber type devices that can provide

a localized pressure around particular irregularities in the substrate surfaces. Preferably, the surface area of the dauber is somewhat larger than the area of a rivet that would conventionally appear on a truck. Thus, a preferred pressure application device has a pressure-imparting surface of about 7 cm diameter. Alternatively, the Heat Neutral Pressure Source is in the form of a roller, much like a paint roller. Preferred width of the roller depends on the application. For applying film to a corregated surface or a surface with rivets, a roller width of 2-15 cm is generally preferred. The Heat Neutral Pressure Source thus is preferably designed to impart essentially perpendicular force with respect to the substrate with little or no transverse force to the film during application.

Most preferably, the pressure source is an open cell foamed silicone material.

In the method of the present invention, the film to be applied to the substrate is heated to the softening temperature, i.e. such that it is highly flexible and soft as compared to the film's behavior at room temperature. More preferably, the film is heated to nearly its melting temperature – just below the temperature at which the film would discolor or develop holes in the film.

In one aspect of the present invention, a method of adhering an adhesive coated film to a substrate is provided by heating the film to the softening point of the film and applying the soft film to the substrate with pressure using a Heat Neutral Pressure Source. Optionally, the entire film could be heated and applied at the same time. Alternatively, the film could be applied to an irregular surface without heating, maximizing the contact of the film to the substrate. This first step of application leaves portions of the film that are not in actual contact with the substrate, but which are "tenting" between adhesively contacting portions. Those portions of the film that are not in contact with the substrate are then heated to the softening point of the film, and applied to the substrate with pressure using a Heat Neutral Pressure Source. Thus, the Heat Neutral Pressure Source is used to actually move the soft film into contact with the substrate. Surprisingly, due to the Thermal Conductivity and surface characteristics of the Pressure Source, the film fully conforms to the surface without damage to the film.

Preferably, the application of heat and pressure as described above is carried out using a heat source and a separate pressure source. This may be a two-person operation, wherein one person operates the heat source and a second person quickly follows with the Pressure Source. More preferably, one person may carry out the method by using a hand-held heat source (much like a hair dryer, in one hand) and a hand held Pressure Source (much like a dauber) in the other hand. The method thus may proceed in a rhythmic motion of first applying heat with one hand, and immediately applying pressure with the other, down a row of rivets or the like.

In the method of the present invention, it is often desirable to first provide air holes in the film immediately surrounding the surface irregularity at the portion where the film is not in contact with the substrate prior to heating the film. Such air holes provide an escape route for air that is trapped between the film and the substrate. Preferably, the pressure source is able to allow air to escape during application of pressure to the film, so that the air to be released through the air holes is not impeded by application of pressure by the pressure source. Most preferably, the foam material is an open cell foam material that readily permits the transfer of air. Preferably, the cells of the foam material of the pressure source are not so large as to imprint the cell pattern onto the softened film. Thus, the pressure source preferably has cells that are no larger than about 0.5 mm in diameter, and more preferably no larger than 0.2 mm.

Particularly preferred pressure sources of the present invention comprise a low energy surface that is in contact with the softened film at the time of film application. Such low energy surfaces include silicone materials or silicone-coated materials. Additional such low energy surfaces include materials or coatings comprising perflorinated materials or other such materials known in the low adhesion backsize art.

In another aspect of the present invention, a kit for application of heat and pressure is provided comprising a heat source adapted for application of heat to a film, and a pressure source that is heat neutral, which may be used in conjunction with the heat source for application of a film to an intended substrate. Another

aspect of the present invention is to provide a unitary article for application of both heat and pressure to an adhesive coated film.

Another aspect of the present invention is a method of adhering an adhesive-coated film to a substrate having a surface, comprising the step of adhering the film to the substrate using an article of the present invention to apply heat and pressure at the surface, wherein the source of pressure on the article is heat neutral.

Another aspect of the present invention is a method of saving labor of adhering an adhesive-coated film to a substrate having a surface, comprising the steps of (a) distributing a film to a party that have been taught to use the applicator of the present invention and the method of the present invention; (b) optionally permitting such party to print the image on the film; and (c) permitting such party to use the application kit or applicator and method to adhere the film to the substrate.

A feature of the present invention is the article provides both heat and pressure to a location of surface irregularity on the substrate in a time-space manner that provides thermal and mechanical alteration of the film at the location of surface irregularity or compound geometry and in a manner that the pressure source is heat neutral.

Another feature of the present invention is the article provides such heat and pressure at a location on a large flat surface during adhesion in such a manner that minute stresses in a film being adhered to the flat surface are removed prior to adhesion.

The present invention provides a labor savings of such significance that the overall total cost may be substantially reduced for the application of an image graphic film to a large vertical substrate having compound geometrical or irregular surfaces. Even with the cost of film remaining constant, the labor savings reduces as much as 50 percent total cost for the application of a non-printed film to a corrugated and riveted trailer. Further, the present invention makes is possible to adhere films to trailers and other challenging environment area with comparatively low stress and/or film memory, such that adhesives that are much less aggressive may now be used in these challenging environments. Thus, removable or

repositionable adhesives may now much more readily be used. This is a significant advantage, because the end user may now more easily remove the films of the present invention due to the lower aggressive adhesives that may now be used. Removal costs of such films may be substantially reduced, on the order of 50%.

Preferably, the applicator and method of the present invention can be used with little training so that less skilled employees and consumers can operate the applicator to obtain properly adhered films on substrates.

It is contemplated that the present invention provides for a significant broadening of the adhesive selections for application of a film to a surface, including any of pressure-sensitive adhesives, pressure-activated adhesives, and heat-activated adhesives.

Further, it is contemplated that a much broader selection of films is now possible for use in application of graphics to various substrates, such as elastic films that normally would be unavailable for a graphic application. Such films that would ordinarily exhibit significant memory upon application to uneven substrates now can be thermally relaxed during application to remove residual stress. This opens many different types of elastic films otherwise unavailable for graphic marking films on uneven surfaces, such as unoriented polyolefin films, polyurethane films, ionomeric resin films, acrylic films, fluoroelastomeric films, and the like.

Further, the present invention enables the use of rigid films that exhibit good handleability and durability, because such films are now capable of being softened at the time of application to conform to irregular or compound curve surfaces. Examples of rigid films are poly(meth)acrylates films, rigid polyvinyl chloride sheets, polyester films, oriented polyolefin films, polycarbonate sheets, styrene sheets, and the like.

DETAILED DESCRIPTION OF THE DRAWING

Fig. 1 is an illustration of an article of the present invention. An applicator 10 contains a heat source 12 and a pressure source 14 wherein the pressure source is constructed of a heat neutral material. A film 30 is applied to a surface 40 of a substrate 50, having a location 52 where film 30 is adhered and a location 54 where

film 30 has not yet been applied. Applicator moves in a direction 60. Heat source 12 can have a nozzle 70 for directing heat toward the film 30 at the location 54 before film 30 is contacted by pressure source 14 in the form of a roller that is constructed of a material that conforms to any surface irregularities or compound geometrical locations on surface 40 of substrate 50. The film 30 at location 54 receives an intersection of heat and pressure but not combined heat and pressure within the pressure source 14. Thus, the film 30 is heated before contacting the surface 40, but any dissipation of heat occurs through the substrate 50 not the pressure source 14. In this manner, unexpectedly, the intersection of heat and pressure for the film 30 does not harm the structure of the film 30 or mar its surface that can contain an image graphic.

Fig. 2 shows an surface applicator 110 for a substrate (e.g., utility vehicle such as a truck trailer or delivery van) that by design has surface irregularities of rivets andor curves at corrugations, where the applicator 110 has a heat source 112 and a surface-conforming pressure source 114 connected by a frame 116 with a first handle 118. Optionally, but preferably, the applicator 110 also has a second handle 120 for guiding the applicator 110, a temperature sensor 122 for measuring the temperature of the heat source 112, a temperature controller 124 for controlling and optionally displaying the temperature measured by the sensor 122. The frame 116 should provide sturdy but lightweight support for the other elements of the applicator 110 and can be constructed from materials such as lightweight metal or rigid polymer.

The heat source 112 can be any heat source that is capable of generating temperatures such that the film is maintained at a softening point for the film until pressed against the irregular or compound surface by the pressure source 114. At that temperature, the film is softened and exhibits little or no tendency to recover making the film conformable for adhesion to the irregular surface or compound surface. Preferably, the temperature ranges from about 150°C to about 350°C, depending on the composition of the film to be softened. Nonlimiting examples of such heat sources include heat guns generating hot air; quartz heaters generating infrared radiation; propane; and the like. The power for such heat source 112 can be connected to the frame 116 or remote from the frame 116, either an electrical or

fuel heat element with a fan or compressed air source. Preferably, the heat source 112 is an electrical heating element of at least 300 Watts of power with a temperature sensor 122 and temperature controller 124. As seen in Fig. 2, a source of air to be heated by heat source 112 can be a remote air blower 125 connected to frame 116.

The applicator 110 has a pressure source 114 that has a compliant surface that has low thermal conductivity. Generally, the pressure source 114 is a surface used to press the film into position, should match the irregularity of the substrate surface, and should retain the heat from heat source 112 until the film is brought into contact with the substrate surface. In the embodiment of Fig. 2, a roller 114 is used that rotates on an axle 126 mounted on the frame 116. Nonlimiting examples that have both a compliant surface and low thermal conductivity include natural or synthetic rubber; urethane polymers; silicone polymers (such as Rogers 800 PoronTM silicone foam, ½ inch thick) ; fluoroelastomers; and especially foamed version of those materials; and the like.

The use of applicator 110 is enhanced from the positioning of a second handle 120 on the frame 116 along an axis near the point where the heat source 112 and pressure source 114 intersect on the film adhered to the substrate. This forward position for second handle 120, along with first handle 118 trailing the point where the heat source 112 and the pressure source 114 intersect, create an axis X-X of application for applicator 110 along the substrate. This axis X-X helps a person guide the applicator 110 for labor-saving, single-pass use of the applicator 110.

Applicator 110 is constructed to deliver heat around a deflector 128 to either nozzle 130 or nozzle 132. The direction of heat is distributed by a baffle 134 with a movable wing that impedes the flow of heated air to either nozzle 130 or nozzle 132. The baffle 134 is controlled by a linkage 136 to handle 120 that can pivot forward or backward along axis X-X. Thus, with minor motion, a person using applicator 110 can shift handle 120 to control the direction of heat reaching the film. That control of direction permits the applicator 110 to be used in both directions along axis X-X because it is a feature of the invention to heat the film before adhering it with pressure to the substrate.

Fig. 3 shows an alternative embodiment to that seen in Fig. 1. In this illustration, an applicator 310 has a heat source 312 and a pressure source 314 to apply film 330 to surface 340 of substrate 350. Heat source 312 supplies heat to film 330 in the form of radiation such as infrared rays. In this manner, convection is not used to transport heat to the film as was used in the embodiments shown in Figs. 1 and 2.

Fig. 4 shows another embodiment to that seen in Figs. 1 and 3. In this embodiment, applicator 410 has a heat source 412 and a pressure source 414, but heat source 412 directs heat toward a film 430 rotating on pressure source 414 before application of the film 430 to a surface 440 on a substrate 450. This embodiment demonstrates that the location of heating of film can occur on the pressure source as the pressure source is delivering the film to the substrate.

Fig. 5 shows an embodiment for a different type of surface irregularity or compound surface on an image graphic substrate surface: a rivet used to join the surface to a reinforcement on the opposing surface of the substrate. Rivets proliferate on a truck trailer or delivery van and are very time-consuming to assure film adhesion thereto. In this embodiment, applicator 510 has a heat source 512 and a pressure source 514, where the pressure source 514 is annular about the heat source 512. The annular pressure source 514 is sized to accommodate the raised, compound-curved surface of the rivet. Source 514 can be altered to accommodate any other irregular surface shape such as channels, grooves, depressions and other protrusions and indentation. Concentrically within or without the annular pressure source 514 is the heat source 512, such that the film contacting the raised, compound-curved surface of the rivet or the film surrounding the entire rivet, or both, can be heated concurrently with the application of the pressure source 514. Both the heat source 512 and the pressure source 514 are mounted on a frame 516 that has a handle 518. Frame 516 also contains an exhaust port 520 that permits air to escape from the heat source after the annulus of the pressure source 514 has contacted the surface of the substrate about the rivet.

The materials used for heat source 512, pressure source 514, and frame 516 can be the same as the materials used for heat source 112, pressure source 114, and frame 116 seen in Fig. 2. Optionally, applicator 510 can also have a temperature

sensor 522 and a temperature controller gauge 524 in locations as seen in Fig. 5 for the same purpose as described above with respect to the embodiment seen in Fig. 2.

Because heating and cooling rates of a typical image graphic film are several hundred degrees per second, the films very often cool to near room temperature before the forming/application can be completed when the conventional assembly technique is used. Films applied when the film is not suitably softened exhibit stress that can cause the adhesive bond to fail. Failure causes the film to lift off the surface, which results in poor appearance and film loss. Lifting failures decrease as pressured applications are made that approach the melting point of the film being applied.

Any of applicators 10, 110, 310, 410 or 510 permit one skilled in the art to apply film at or near its melting point without damaging the film. The use of a heat source and a pressure source intersecting concurrently at irregular or compound surface location(s) where film is under stress unexpectedly minimizes damage to the film. While the film is hot, it is pressed into position using a roller 14, 114, 314, 414 or annular ring 514 that does not dissipate the heat. When the hot film contacts the receptor surface, it is immediately quenched. This process reduces residual stress in the film to a level that can be overcome by many adhesives, including those that are considered low performance or removable.

Any adhesive-coated film can benefit from the applicators of the present invention. Nonlimiting examples of such films include any film presently sold by Minnesota Mining and Manufacturing Company (3M) of St. Paul, MN, USA under the brands of Scotchcal™; Controltac™ and the like.

It has been found that an adhesive-coated film, namely Controltac™ 180 film can be successfully adhered using the applicators of the present invention at air temperatures ranging from about 200°C to about 400°C, but the actual film temperature is best raised to 170 to 200°C. It has also been found that use of conventional heat sources that are separated in time and location from pressure sources can generate the necessary temperatures, but use of the rivet brush requires the film to cool to approximately 100°C, which is insufficient to permanently re-form the film about the surface irregularity of the substrate. Controltac™ 180 Film

(commercially available from Minnesota Mining and Manufacturing Company) having adhesive disclosed in PCT Patent Publication WO 98/29516 was applied to white painted corrugated metal panels containing numerous rivets to simulate the outer surface of a truck trailer. The film liner was removed and the film was laid across the tops of the corrugations with light pressure applied to provide initial adhesion. An applicator resembling the illustration seen in Fig. 2 was then rolled down into the valleys between corrugations where the pressure source had a soft urethane foam roller while applying heat at various temperatures. The temperatures were recorded as displayed on a Steinel heat gun commercially available from McMaster Carr. The panels with the adhered films were then placed in an aging oven for 6 days and heated to 79°C. The panels were then removed from the oven and left untouched for three weeks before measuring the natural lifting of film from around the rivets. The results are seen in Table 1 as follows.

Table 1

Application Temp (°C)	Average Lifting at Rivets (cm)
65	0.396
93	0.277
121	0.317
149	0.317
177	0.256
204	0.119
232	0.119
260	0.109
288	0.045

These results show that hot air temperatures above 200°C for vinyl films significantly reduces natural lifting of the film around rivets. The articles of the present invention are able to provide such heat with a separate, Heat Neutral Pressure Source that is conformable to the surface irregularity or the compound curve of the surface to achieve durable adhesion of the film to the substrate.

It has also been found that as much as 80 % of the time normally required for adhering a film on a corrugated and riveted substrate can be saved, reducing the total cost of adhering such film by as much as 50 %.

With the use of removable or repositionable adhesives on films, the cost of removing such film can also be substantially reduced. Films with removable or repositionable adhesives include Scotchcal™ Series 3500 films commercially available from Minnesota Mining and Manufacturing Company of St. Paul, MN, USA as marketed by its Commercial Graphics Division.

For purposes of the present invention, an adhesive is considered to be "removable" if, upon application to an intended substrate the product ca be removed without damage to the substrate at the end of its intended life at a rate in excess of 25 feet/hour (7.62 meters/hour)by hand with the optional use of heat.

An entirely new business method can be created using the applicator and methods of the present invention. The business method comprises contracting with an owner of an image to make that image on a graphic marking film, wherein the maker of the graphic marking film prints the image and assembles the image graphic film onto a substrate using the applicator and method of the present invention. Alternatively, the film maker can subcontract the use of the applicator and method to permit remote subcontractor(s) to assemble the graphic film(s) on the substrate(s) for further distribution or usage. Preferably, the image is distributed to multiple remote locations and printed and assembled using the same techniques as all locations, all benefiting from the labor savings afforded by the applicators and methods of the present invention.

The following claims identify the scope of the present invention.